



U.S. Department of Energy

ANALYSIS OF BENEFITS AND COSTS (ABC) GUIDELINE

VOLUME 2: AN ANALYST'S HANDBOOK FOR ANALYSIS OF BENEFITS AND COSTS

March 2008

**Office of the Chief Information Officer
Associate CIO for Information Technology Planning,
Architecture, and E-Government
Division of IT Capital Planning and Architecture
Washington, DC 20585**

Version Control No. – FS-GU-FI01-022908

Title Page

Document Name: Analysis of Benefits and Costs (ABC) Guideline,
 Volume 2: An Analyst's Handbook to Analysis of Benefits and Costs

Document Owner: Department of Energy
 Office of the Chief Information Officer
 Office of the Associate CIO for Information Technology Planning,
 Architecture, and E-Government
 Division of IT Capital Planning and Architecture

Revision Date: March 2008
Original Date: June 1988

Effective Date: As of Approval Date

Approvals:

_____ Date: _____
Brenda Coblentz, Document Developer, IM-21

_____ Date: _____
Denise A. Hill, Director, IM-21

_____ Date: _____
Theanne E. Gordon, Associate CIO, IM-20

_____ Date: _____
Thomas N. Pyke, Jr., Chief Information Officer

**THIS IS A WORKING DOCUMENT THAT HAS NOT RECEIVED DOE
MANAGEMENT SANCTION FOR PUBLICATION, IS SUBJECT TO REVISION,
AND SHOULD NOT BE CIRCULATED OUTSIDE OF THE RECEIVING OFFICE.**

Change History

The following information is being used to control and track modifications made to this document.

Section	Date	Description of Revision
Overall	March 2008	Updated organizational references and directive cites

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government, any agency thereof or any of their contractors or subcontractors. The views and opinions expressed herein do not necessarily state or reflect those of the United States Government, any agency thereof or any of their contractors or subcontractors.

Table of Contents

	Page
I. INTRODUCTION	1
1.1 ABCs Defined	1
1.2 Uses of ABCs	1
1.3 Structure of this Handbook	4
II. DEFINING THE INITIATIVE	5
2.1 Establish Objectives	5
2.2 Formulate Assumptions	6
2.3 Identify Alternatives	6
III. ANALYSIS OF BENEFITS	9
3.1 Identifying Benefits	9
3.2 Quantifiable Benefits	9
3.3 Non-Quantifiable Benefits	14
IV. ANALYSIS OF COSTS	20
4.1 Cost Accounting Problems	20
4.2 Estimating Costs	21
4.3 Cost Elements	21
4.4 Other Considerations	22
V. HOW TO COMPARE ALTERNATIVES— COMPUTATIONAL TECHNIQUES	24
5.1 Present Value Analysis	24
5.2 Net Present Value (NPV)	25
5.3 Graphic Presentation of Net Present Value	25
5.4 Benefit-Cost Ratio	26
VI. How to Refine the Analysis (Sensitivity Analysis)	28
Appendix A: Example - System “X” ABC	A-1
Appendix B: Sample Forms	B-1

List of Exhibits

Exhibit		Page
3-1	Potential Categories of Benefits for Alternative IRM Investments/ Projects	10
3-2	Typical Quantifiable Benefits	12
3-3	Assigning Values to Non-Quantifiable Benefits	17
3-4	Weight Ranking Chart - Alternative B	18
3-5	Comparison of Alternatives - Non-Quantifiable Benefits	19
4-1	Typical Cost Categories for Alternative IRM Investments/ Projects	23
5-1	Discount Factors Based on a 10 Percent Discount Rate	26
5-2	Present Value Analysis - Alternative X - Summary of Alternative Benefits and Costs	27

I. INTRODUCTION

This handbook is for information technology personnel with little or no previous experience in the analysis of benefits and costs (ABC). This handbook describes the essential concepts and procedures necessary to conduct an ABC. It also explains the use of ABCs to support decisions related to information resources management (IRM). A companion volume, "*A Manager's Guide to Analysis of Benefits and Costs*," explains the importance of ABCs to the Department of Energy's IRM decision-making process.

1.1 ABCs DEFINED

An ABC is a systematic approach for comparing alternative ways to satisfy an objective. ABCs provide a structured framework for identifying alternatives, organizing data, and making decisions. The ABC process includes:

- Identifying all reasonable alternatives for satisfying stated objectives. (A reasonable alternative is both technically and operationally feasible.)
- Identifying benefits and costs of each alternative, over the investment/project lifecycle.
- Determining when benefits and costs will occur.
- Comparing alternatives.

The structured framework ABCs provide is useful in a variety of different situations. ABCs provide a tool by which factors affecting a decision are qualified and quantified to aid decision-makers. ABCs also include evaluating qualitative information for its impact on the decision. While ABCs do not remove all uncertainty, they help clarify the impact of choosing among alternatives.

1.2 USES OF ABCs

ABCs provide input to a series of decisions made throughout an investment's/project's lifecycle. There are five distinct points where ABCs, or modified versions of them, can aid decision-making.

- Investment/project initiation—The initial decision to proceed.
- Investment/project development—The selection among alternative methods for meeting an investment's/project's requirements.
- Budget Formulation—The selection of a financing option for a particular alternative.
- Investment/project Acquisition—The choice among competing vendor proposals.
- Investment/project Review—Post-implementation monitoring.

The first decision is whether or not any initiative should be attempted (Go or No-Go Decision). An ABC is important at this stage in determining the economic feasibility of an investment/project. Often, its primary purpose is to compare the present system (status quo) to a proposed change.

Note that per guidelines in OMB Circular No. A-11, Part 7, OMB requires the development of three alternatives in addition to the status quo alternative.

The second decision is determining which alternative solution is most desirable. This decision depends on a defined set of requirements. It then requires a comparison among alternatives to determine which technical solution is most economical. At this stage, the ABC requires a different focus than the Go or No-Go Decision. The definition and analysis of different alternatives must be more precise. For many investments/projects the differences in benefits among possible alternatives are quite small since they all meet the same requirements. Therefore, the major focus should be on defining system lifecycle costs as precisely as possible.

The third decision is a specific type of ABC to determine how to fund investments/projects. While results of earlier ABCs support budget requests, a detailed analysis will help establish the type of funds to request (i.e, capital versus operating funds). These analyses address the method of acquisition (i.e., purchase, lease, lease-to-ownership, lease-with-option-to-purchase, etc.). Some may address software development (e.g., develop software in-house, purchase commercially available software, etc.).

The fourth decision usually occurs during investment/project implementation. If it is decided to acquire or contract for an information resource capability, a modified ABC can aid in conducting a cost comparison of the proposals. This type of ABC, currently used by the Department of Energy, consists of evaluating the technical capability of proposals to fulfill the system specifications, as well as their lifecycle costs, against predetermined criteria. This analysis assists in selecting the proposal most advantageous to the Department of Energy.

The last decision is reviewing whether the investment/project accomplished its intended results. A comparison of actual benefits and costs to those projected in prior ABCs helps managers evaluate whether the initiative has met its goals. ABCs used for post-implementation reviews can help identify patterns that may require changes in the assumptions of future ABCs. This information when shared throughout the organization will improve future ABCs and decisions. An ABC at these points provides information to decision-makers at key times in the investment/project lifecycle. This guideline is intended to help local managers improve their decision-making ability. It is not intended to address external requirements.

The following illustration shows how an ABC is used at each point of the investment/project lifecycle. Suppose an organization has responsibility for collecting and updating a certain type of information. The information is currently gathered and updated manually. The manager believes it would be more efficient to develop an automated database to manage this information. An ABC would compare the cost of collecting and maintaining the information manually in the present system (status quo) versus the cost of automating collection and maintenance. Costs for

automating the database would be rough estimates based on industry averages. Benefits derived from automating may include savings in personnel costs due to increased productivity.

If the initial ABC shows the present system (status quo) is the cost-beneficial alternative, no change is warranted. If the ABC shows that automation might prove cost-beneficial, further analysis is appropriate. In this case, the ABC supports a decision to conduct further research.

The next stage of this investment/project is an analysis to identify what the new system must do to meet the needs of the organization (i.e., requirements analysis). The various technical alternatives, which meet system requirements, are defined and evaluated. These alternatives might specify different technical solutions, such as levels of automation, to meet the requirements. For example, alternatives might be the use of a mainframe computer, minicomputer network, or commercial timesharing services. Different types of software might also be specified as alternatives. In any case, all technologically and operationally feasible alternatives are considered.

Moreover, alternatives need to be analyzed in as much detail as possible. This will assure the manager has all the pertinent information regarding the effect of choosing one alternative over the others. Particular attention is also paid to the evaluation of benefits which are not easily quantified. If no method is found to quantify benefits, then a complete narrative explanation is required. The more information available about each alternative, the more likely the decision-maker will select the best alternative.

After selecting an alternative, an ABC can evaluate the financing options. The ABC will provide the decision-maker with information about how different methods of acquiring a system (purchase, lease, etc.) affect costs over the investment's/project's lifecycle.

If the investment/project requires a contract to obtain equipment or services, an ABC can aid in conducting a cost comparison of the alternative proposals. The technical capability of the proposals to fulfill the system specifications is evaluated against the criteria established in the solicitation request. The result of this evaluation is the benefit analysis portion of an ABC. The lifecycle cost of each proposal is also evaluated during this modified ABC. Comparing both benefits and costs to predetermined criteria (from the solicitation) assists in selecting the most advantageous proposal.

Finally, after an investment/project is implemented, an ABC can help measure the results. If costs/benefits are significantly higher/lower than projected, the manager may inquire whether a change in implementation would bring actual results closer to projections. If the gap between estimated and actual benefits and/or costs is consistently inaccurate, a component of the ABC process may need examination. The ABC can identify changes in assumptions or estimating techniques that will help make future ABCs more accurate.

1.3 STRUCTURE OF THIS HANDBOOK

The ABC process described in Volume I consists of eight basic steps:

- Define Objectives
- Formulate Assumptions
- Identify Alternatives
- Estimate Benefits and Costs
- Compare Alternatives
- Conduct Sensitivity Analysis
- Present Results
- Select Alternative and Recommend Course of Action

The remaining chapters of this handbook explain the major steps in the ABC process. Chapter II, Defining the Initiative, discusses the first three steps of the process. These steps, which often occur simultaneously establish the overall framework for the analysis. Chapters III and IV provide advice on how to estimate the benefits and costs of an IRM investment/project. Chapter V introduces the concept of present value analysis and the net present value and benefit-cost ratio comparison techniques. Chapter VI describes how to conduct a sensitivity analysis. Appendix A provides a sample of how to present the results of an ABC. Appendix B provides sample forms that can be used to summarize the analysis. The final step of the ABC is to make a recommendation to the decision-maker. This should follow logically from the prior steps in the process and is, therefore, not discussed in detail in this volume.

This guideline will assist the analyst in conducting an ABC (i.e., how to conduct the analysis and present results). However, the analyst should determine the best way to analyze an investment/project to meet the needs of his/her decision-makers. To do this, the analyst will want to discuss the investment's/project's specific characteristics with the investment/project manager.

As mentioned previously, an example of the direct application of the ABC process is included as Appendix A. The example provides a demonstration of the various elements described in the guideline. The example, entitled "System X Upgrade" is an ABC to compare alternatives of automating an administrative process conducted at 15 locations throughout the country. Currently, this process is partially automated but requires an upgrade to meet additional requirements.

II. DEFINING THE INITIATIVE

The steps in defining the initiative for an ABC include establishing the objectives, formulating assumptions, and identifying all technologically and operationally feasible alternatives. Clear formulation of the objectives, assumptions, and alternatives makes it easier to identify benefits and costs.

2.1 ESTABLISH OBJECTIVES

The first step in the ABC process is establishing the objectives of the IRM initiative. In general, objectives are the requirements, goals, or results the organization wants to achieve through the initiative. Therefore, investment/project objectives need to be specified clearly in terms of overall organization goals and capabilities. Investment/project objectives may change in light of additional information uncovered during the ABC. It is not unusual to restate investment/project objectives several times during the ABC process. For example, a manager may ask for an ABC of a system with the objective to process vendor payments within 2 weeks of receiving an invoice. During the analysis, the study team uncovers information that the 2-week period may cost the organization a significant amount of lost interest. In this situation, the team may revise the system objective to processing vendor payments in the most economical manner.

Objectives are not always process-oriented. The objectives of IRM investments/projects can be to help the organization meet its programmatic missions or goals. For example, assume an organization has the responsibility to track hazardous materials as they are shipped across the country. The objective of this investment/project could be to provide the information needed to track the hazardous material by providing data such as the shipping date, delivery date, and the route of each delivery. Another objective could be to provide information regarding the potential hazards of the material being shipped.

Another example of a nonprocess-oriented objective could be to provide more accurate financial data, so that management can be better informed of the current overall financial environment of the company or of specific investments/projects such as the amount of funding remaining to complete construction of Investment/Project X or the amount of operating funding left for the lease of major computer equipment items.

The actual wording of the objectives is critical. They should reflect a totally unbiased point of view concerning the method of solving the problem. Objectives should contain enough detail so they provide a firm basis for selecting alternative methods of accomplishment. Objectives can also determine the extent to which existing methods and procedures should change. For example, the objective of an investment/project to update an existing system should specify what new requirements the updated system must meet. It would not be sufficient to state the objective as "to update" (or upgrade) the current system. Objectives should also contain enough detail to allow for measurement of the results after the new system is in operation. However, they should not be so specific that they unnecessarily limit alternatives.

In many cases, an objective is the solution to a problem or an improvement opportunity. However stated, objectives should provide enough detail for a firm basis to formulate assumptions and develop alternatives that have measurable results.

2.2 FORMULATE ASSUMPTIONS

Assumptions are statements that describe uncertain events in the present and future. The purpose of stating assumptions is to define their effect on the scope of the study. Assumptions need to be explained and justified by sound reasoning so decision-makers will know what is and is not included in the analysis. Examples of assumptions include proposed investment/project implementation schedules, projected system life, workload projections, and elements excluded from the investment/project.

Three rules to observe in making assumptions are:

- Make assumptions only when they are absolutely necessary to bridge gaps in essential information.
- Be certain the assumptions are realistic and stated positively.
- Include only assumptions that affect conclusions of the ABC. See Chapter VI concerning sensitivity analysis for a discussion or testing the validity and impact of assumptions.

Three significant assumptions included in every ABC are:

- The lifecycle of each alternative.
- The workload of each alternative.
- The period for comparing alternatives.

These assumptions are important because the timing of each benefit and cost affects the results of the analysis.

System Lifecycle—The lifecycle of alternatives includes the time required to design, acquire, and implement the alternative and its operational life.

2.3 IDENTIFY ALTERNATIVES

An ABC requires an analyst to identify all technologically and operationally feasible means of meeting the investment's/project's objectives. At a minimum, there are at least two ways to meet each objective (i.e., maintaining the present system (status quo) and a proposed alternative). It is a good practice to consider a reasonable number of alternative methods for satisfying investment/project objectives. Every ABC should have several alternative solutions depending on complexity, resource investment, etc. By developing multiple alternatives, decision-makers can decide which is most prudent in light of their situation. At the very least, one alternative which should be considered is maintaining the present system (status quo). Sample alternatives in IRM investments/projects include, but are not limited to:

Hardware Alternatives

- Present system (status quo).
- Mainframe with remote nodes/terminals.
- Centralized versus distributed (decentralized) processing.
- Mini/microcomputer network.
- Different vendors.

Software Alternatives

- Continuation of current services and methods (status quo)
- A new system that meets only the most important of the identified requirements, (i.e., a scaled-down version which meets only a subset of requirements). If a scaled-down alternative is not feasible, the ABC should so state.
- A new system that meets all the requirements.
- A second system that meets all the requirements, but uses a different approach.

Acquisition Alternatives

- The purchase alternative — buying a system.
- The lease alternative — making regular payments for the use of the system.
- The lease-with-option-to-purchase alternative — making regular payments until a certain point at which time a lump sum may be paid to purchase the system and ownership passes to the Government.
- The lease-to-ownership alternative — making regular payments until a point at which ownership passes to the Government.

Implementation Alternatives

- Contract for system development, operations, maintenance, and/or services.
- Contractor developed/in-house operated.
- Contractor developed/contractor operated.
- Timesharing from commercial sources.

The types of alternatives that are appropriate to develop and evaluate will depend on the particular decision that is being made.

In defining alternatives, the analyst may need to limit the number of alternatives considered by the ABC. Too many will result in a condition known as "information overload" (i.e., the frequent observation that many managers have "an overabundance of irrelevant information" rather than a "lack of information").

Finally, the list of alternatives compiled in the beginning of the ABC is not always final. In some cases, organizations may develop a number of alternatives which are individually weak or flawed. Combining these alternatives may lead to a superior alternative with better potential to satisfy an organization's requirements. In addition, as the analysis proceeds, more alternatives may be identified.

The analyst should begin screening alternatives at the outset of the study to eliminate those that do not seem reasonable or practical. The final report should identify rejected alternatives and provide brief justification for their rejection.

Appendix A, pages A-1 and A-2 contain an example of "Defining the Initiative."

III. ANALYSIS OF BENEFITS

In conducting an ABC, an analyst must identify the benefits for each alternative being considered. Whenever possible, benefits should be quantified. However, benefits such as "tighter management control," "improved information handling," "better decisions," or "improved organizational image" are not easily quantified. This chapter provides guidance for identifying and quantifying benefits. It also provides guidance for evaluating those benefits that are not quantifiable.

3.1 IDENTIFYING BENEFITS

The first step in an analysis of benefits is to list the benefits for each alternative. The analyst should describe all expected benefits whether or not they can be quantified. Descriptions of benefits should relate to organizational goals, objectives, missions, functions, and operating environment.

One method to identify benefits is to form a group of users, managers, and professionals with knowledge of the investment/project being analyzed. This group can brainstorm to identify the possible benefits of the investment/project. They can then identify the extent to which each alternative provides the different benefits. The more input, the greater likelihood that the analysis will include all important benefits. In addition, group analysis is helpful in understanding the significance or insignificance of non-quantifiable benefits.

The result is a list of all benefits to use in evaluating the alternatives. The list should define each benefit, if possible, in quantitative terms. The benefits for any alternative may fall into one of many categories. Exhibit 3-1 provides a list of categories which may help to identify benefits. This list is not all-inclusive; it is only illustrative of benefit categories that could be applicable to IRM investments/projects.

3.2 QUANTIFIABLE BENEFITS

Dollar values are assigned to benefits which are either one time (non-recurring) or occur over the life of the investment/project (recurring). Benefits result from improved operations or decreased operating costs. They are the benefits typically identified with IRM investments/projects.

Benefits can also result from an increase in services to the organization or the organization's clients (e.g., more timely response to inquiries). These benefits are usually service improvements not provided by the present system (status quo). Exhibit 3-2 provides a sample of quantifiable benefits typically associated with IRM initiatives.

EXHIBIT 3-1

POTENTIAL CATEGORIES OF BENEFITS FOR ALTERNATIVE IRM INVESTMENTS/PROJECTS

Acceptability—Does the alternative meet the needs of the primary user(s)? Does the alternative contribute to the operation of parallel or higher level organizations? Does it improve quality of information for decision-makers?

Accuracy—Does the alternative decrease error rates or improve the correctness of information? To what extent does it do either of these?

Adaptability—Does the alternative's software for the system allow differing system constraints and user needs to be satisfied? Can the alternative's hardware be used for other tasks for which the organization is responsible?

Availability—What is the probability that the software and/or hardware of the alternative will be able to perform its designated system function(s) when required by the investment/project? How long will it take for the alternative's software and/or hardware to be implemented and does that date satisfy documented user requirements?

Compatibility—How will existing operations, facilities, equipment, and data requirements be affected by the alternative? How much initial training will be required? How will work methods/procedures have to be altered?

Efficiency—Will the alternative's software perform its intended mission/functions with a minimum consumption of computing resources? How quickly will it process the data or calculations? Is it fast enough to satisfy documented requirements?

Maintainability—How much will the alternative's implementation increase the maintainability of a functional unit? Does this level of maintainability satisfy documented requirements?

Manageability—How will the alternative impact the involvement/need for supervisors or quality inspections? Will the alternative require a different type of worker than currently used? Are trained workers available? If not, are they readily trainable?

Morale—How will the alternative contribute to a positive employee attitude towards work?

Performance—How will the alternative's computer system and/or its subsystems perform their required functions (e.g., with adequate throughput, response times, and/or number of transactions)?

Portability—How easily can the software of the alternative be transferred from one computer system or environment to another?

Productivity—How will the rate of production (e.g., number per hour, etc.) increase if the alternative is selected? Will the alternative decrease the number of staff resources previously needed to produce the same product, or will the alternative allow more items to be produced with existing staff resources? Does the rate of productivity satisfy the documented requirement?

Quality—Will a better product be produced by the alternative? Will better service be provided? Will the quality of products be more consistent?

Reliability—For software: Will the alternative's software be able to perform its required functions under stated conditions for a stated time period? For hardware: Is the alternative's hardware projected failure rate (mean time between failure/service calls per year) acceptable (i.e., does it meet the requirements of the investment/project)?

Residual Value—Will the hardware and/or software have a value when it is no longer needed for the investment/project?

Safety—Will the software and/or hardware of the alternative promote safety in the workplace?

Security—How will the alternative's system (hardware and/or software) decrease the chance of fraud, misuse of Government resources, theft, etc.? Will the system result in less precautions being needed? If so, what are they? If the system must handle classified/sensitive unclassified data, is there an alternative which provides better security at a "better" cost?

Service Life—Will the alternative's hardware and/or software be able to support the stated requirements for the investment's/project's estimated system life? Does the alternative have a service life which will eliminate the need for replacement hardware and/or software during the estimated system life of the investment project?

Software Quality—Will the composite characteristics of the alternative's software to be used meet the needs/expectations of the primary user(s)?

Upgradability—Will the alternative's software be usable on newer or larger hardware?

Versatility—Will the alternative's software or hardware provide additional capacity/capability beyond that required for the system? If so, is it needed and/or is there an additional cost(s) for the additional capacity/capability not needed by the investment/project?

EXHIBIT 3-2 TYPICAL QUANTIFIABLE BENEFITS

- Reduced Resource Requirements
 - Personnel
 - Lease, Rental, Maintenance
 - Support Services
 - Training
 - Supplies and Utilities
 - Security
- Improved Data Entry
 - Reduced Staff Time
 - Reduced Error Rates
- Improved Information Technology Utilization
 - Storage and Retrieval
 - Performance Monitoring
 - Data Compression
 - Centralized or Distributed Processing
- Improved Operational Effectiveness
 - Reduced Error Rates
 - Improved Timeliness
 - Better Quality Products
 - Increased Productivity
 - Expanded Capacity or Capability
- Cost Avoidance
 - Eliminate Future Staff Growth
 - Eliminate Additional Equipment Requirements
 - Minimize Penalties for Delays

3.2.1 Measuring Quantifiable Benefits

The analyst can directly measure many benefits in monetary terms. For example, investments/projects for modernization or replacement of existing equipment can generate cost-savings relative to the present system (status quo). These savings are a reduction in recurring operating and maintenance expenses. This benefit is quantifiable in direct monetary terms.

Replacing a particular task, function, or piece of equipment is another common information resource benefit. For example, a central data entry operation can be replaced by a remote job entry. The remote job entry station replaces the central data entry operation with a resulting cost reduction. Productivity and accuracy gains through the on-line entry may also translate into personnel savings (value enhancement).

Benefits which are not specifically monetary can often be converted into equivalent monetary values with varying degrees of difficulty. They include benefits such as labor savings and error reduction. An efficiency/productivity increase, typically expressed in person-years, is a benefit whose value includes all direct and indirect labor costs. Direct labor costs are salaries or hourly wages, while indirect labor costs include personnel leave and fringe benefits to reflect the full cost of providing a person-year of labor.

One important value enhancement that is important for IRM initiatives is the avoidance of future costs. Cost-avoidance is future cost that will not be incurred by selecting a proposed alternative, but would be if the present system (status quo) remained. For example, consider a manual process with an increasing workload. Automating the process would avoid the cost of hiring additional staff required by the manual process to handle the increased workload.

An analyst must be careful to avoid "double counting" cost-avoidance as both a reduction in costs and an increase in benefits. For example, in an analysis for replacing an existing information resource, the hardware maintenance costs may be lower for an alternative than for the present system (status quo). The ABC can show the difference as a reduced cost in the cost analysis, or it can show the difference as a benefit when comparing to the present system (status quo). The important point is to include a cost-avoidance item in only one category. The decision on which category to use is left to the analyst.

3.2.2 Measuring and Quantifying Personnel Resources

Personnel resources are often the principal and most costly ingredient of many IRM initiatives. Like equipment, space, and utilities—personnel resources can be measured.

There are many methods available to estimate, sample, or accurately measure personnel effort in any system. Some are extremely accurate, yet costly and time-consuming. Others are relatively easy to perform yet have a greater margin of error. There are four categories of estimating techniques:

- **Estimation**—This technique consists of asking the judgment of supervisors or senior workers and averaging them to lessen bias. This technique is quick and easy, but there is a large potential for error.
- **Simulation**—This technique relies on a flowchart of the proposed system. Industrial engineers make projections of how long each task will take and how many people will be required.
- **Comparison**—This technique relies on identifying similar jobs elsewhere in the organization. The time required to do three similar jobs is used as a baseline for estimating the new system requirements.
- **Observation**—This technique consists of having an analyst measure the time required to perform the tasks by observing and recording the actual time spent. This is valuable when a pilot study approach is used.

Many books on work measurement provide an explanation of these techniques. The choice of which technique to use will depend on the level and scope of the ABC.

3.3 NON-QUANTIFIABLE BENEFITS

Non-quantifiable (also called intangible) benefits can have a major impact on an ABC and the decisions it supports. Non-quantifiable benefits often associated with information resources include but are not limited to:

- Improved decision-making
- Better management information
- Greater versatility or flexibility
- Better presentation of information
- Improved report generation (timeliness)
- Improved staff morale
- Fulfillment of operating requirements

In many ABCs, the analysis of quantifiable benefits may not be sufficient to distinguish a preferable alternative. In these cases, decisions require the evaluation of both quantifiable and non-quantifiable benefits. The goal in the analysis of non-quantifiable benefit is to improve the overall usefulness of the ABC.

There are a number of accepted procedures for analyzing non-quantifiable benefits in an ABC. Many benefits not readily converted to a dollar figure can be expressed in a common unit of measure (such as percentage satisfaction with services provided, etc.). The analyst can compare alternatives when similar benefits are expressed in a common measure.

The procedure used to evaluate non-quantifiable benefits depends on the purpose, scope, and size of the IRM investment/project. For many investments/projects enumeration and ordinal ranking is sufficient. For larger investments/projects, more complex techniques may be necessary to

provide decision-makers with complete information. The discussion below describes several techniques to use in evaluating non-quantifiable benefits.

3.3.1 Simple Techniques for Evaluating Non-Quantifiable Benefits

Enumeration is a "simple listing" of non-quantifiable benefits associated with each alternative. This allows decision-makers to compare non-quantifiable benefits associated with each alternative.

Ranking non-quantifiable benefits by their relative importance to the goals and objectives of the initiative provides a more useful piece of information. Such a ranking describes the degree to which each alternative achieves a given objective. The ranking does not imply a strict quantification of the non-quantifiable benefits. However, it provides the decision-maker a description of all benefits and how each contributes to the investment's/project's goals. This analysis is by nature rather subjective and requires a consensus on the relative importance of the non-quantifiable benefits. In many cases, this is as far as the analysis can go—to include certain non-quantifiable benefits in the ABC. However, the ranking explicitly identifies the differences among alternatives for the decision-maker.

An additional step that can supplement ranking is scoring each alternative on how it contributes to the non-quantifiable benefit. These scores are subjective estimates derived from a meeting of users, managers, and professionals with knowledge of the system, or simply the analyst's judgment. Scoring the alternative provides the decision-maker with a means to compare across alternatives on individual non-quantifiable factors.

A third approach to quantifying benefits is assigning values. This technique involves ranking all benefits, both quantifiable and non-quantifiable, by their relevance to investment/project objectives. First, the analyst establishes dollar values for the quantifiable benefits. The analyst then assigns dollar values to the non-quantifiable benefits based on their position in the rankings. Exhibit 3-3 illustrates the process of assigning values. This procedure is a subjective exercise, and assumptions underlying the dollar values for the intangible benefits need to be explicitly stated.

3.3.2 Complex Techniques for Evaluating Non-Quantifiable Benefits

A fourth technique that is useful for larger investments/projects builds on the ranking procedures described above. This technique¹ weighs the non-quantifiable factors based on their priority or contribution to organization goals. This technique may include quantifiable benefits, but it is not required. The first step is to establish the benefits. Managers, users, decision-makers, or the ABC analyst define the list of benefits for the investment/project. They then rate each benefit on how it contributes to the organization's objectives. The sum of individual ratings establishes the overall ranking for the benefit. The benefit with the highest score is ranked first. Exhibit 3-4 illustrates a representative ranking of benefits for an IRM investment/project. Next, the analyst

¹This technique is derived from Charles Kepner and Daniel Tregoe, The Rational Manager, Kepner - Tregoe, Inc. 1965.

calculates a weight for each benefit that represents a consensus of the group. Weights are the rating of the benefit divided by the sum of rating for all benefits. Column 3 of Exhibit 3-4 shows the weights for the sample investment/project. Weights show the relative importance of each benefit to the organization's goals.

Through this point, the technique has considered the importance of benefits without relating them to specific alternatives. The analyst or committee familiar with the investment/project now scores each alternative against each benefit. The score is a judgment about how well each alternative satisfies the non-quantifiable benefit. Exhibit 3-4, shows the average score for alternative B in column 4. The alternative's scores multiplied by the weight of each benefit (column 3 times column 4) provide a weighted score for each benefit (column 5). The alternative's final score is the sum of weighted scores for each benefit.

The decision-maker can use the final alternative scores, along with the quantified results, to compare the merits of the alternatives. Exhibit 3-5 illustrates a comparison of alternatives using this technique to evaluate non-quantifiable benefits.

Another technique used to evaluate non-quantifiable benefits is the Analytic Hierarchy Process (AHP)². Originally developed at the Wharton Business School, this technique is applied in a broad range of decision areas. This technique is suitable for making large, complex decisions. Because of the effort required to apply AHP, it is not appropriate for small investments/projects. For major investments in technology or systems, it allows decision-makers to analyze large quantities of information. A major advantage of this technique is that several microcomputer software programs can perform the complex calculations required.

The result of the AHP is a quantitative ranking of the alternatives. Appendix A, pages A-3 through A-7 contain an example of the "Analysis of Benefits."

²For more information on the AHP, see The Analytic Hierarchy Process - A Survey of the Method and Its Application, Fatemeh Zahedi, Interfaces, July-August 1986 (pp 96-108)

EXHIBIT 3-3

ASSIGNING VALUES TO NON-QUANTIFIABLE BENEFITS

Step 1	Define Benefits	
	Reduced Inventory	- Quantifiable
	Reduced Maintenance Costs	- Quantifiable
	Timelier Reporting	- Non-quantifiable
	Better Service to Field	- Non-quantifiable
Step 2	Rank Benefits	
	1. Reduced Inventory	
	2. Better Service to Field	
	3. Reduced Maintenance Costs	
	4. Timelier Reporting	
Step 3	Quantify Benefits	
	Reduced Inventory	\$ 75,000
	Reduced Maintenance Costs	\$ 25,000
Step 4	Assign Values to Non-Quantifiable Benefits	
	Reduced Inventory	\$ 75,000
	Better Service to Field ³	\$ 50,000
	Reduced Maintenance Costs	\$ 25,000
	Timelier Reporting ⁴	<u>\$ 5,000</u>
	Total	\$155,000

³In Step 2, “Better Service to Field” was ranked halfway between “Reduced Inventory” (\$75,000) and “Reduced Maintenance Costs” (\$25,000). Thus, “Better Services” was assigned a value of \$50,000.

⁴In Step 2, “Timelier Reporting” was ranked last and was considered significantly lower in value than “Reduced Maintenance Costs”. Thus, “timelier reporting” was assigned a value of \$5,000.

EXHIBIT 3-4
WEIGHTED RANKING CHART - ALTERNATIVE B

1	2	3	4	5
Rank	Benefit (Critical Success Factors)	Weight	Average Alternative Score	(Column 3 x Column 4) Weighted Score
1	Improved work ethic	10.0	10	100.0
2	Increased quality of reports	9.0	2	18.0
3	Develop teamwork	7.4	4	29.6
4	Compatibility with current procedures	7.4	3	22.2
5	Management access to data	5.0	7	35.0
6	Flexibility	3.7	8	29.6
7	Maintainability	3.6	9	32.4
8	Better management decision	3.2	6	19.2
9	Develop better company image	3.1	10	31.0
10	Increase reliability of data	3.0	4	12.0
11				
12				
13				
14				
15				
			Alternative Score	329.0

EXHIBIT 3-5
COMPARISON OF ALTERNATIVES
NON-QUANTIFIABLE BENEFITS

ALTERNATIVE	WEIGHTED TOTAL
A	302
B	329
C	270
D	297

IV. ANALYSIS OF COSTS

An important component of an ABC is identifying and estimating costs. Costs are the value of input used or expended in developing, acquiring, or operating an information resource. Costs are incurred throughout the life of an investment/project. The analyst must consider the cost of acquisition and operation of an alternative over its full lifecycle. The timing of costs are especially important because their value depends on when they occur. (Chapter V discusses the time value of money.) There are three broad categories of costs:

- Sunk costs
- Nonrecurring costs
- Recurring costs

Sunk costs are already expended and not included in an ABC. Examples of sunk costs are the costs of completed research or completed pilot investments/projects. These costs will not change as a result of the ABC and are incurred regardless of which alternative is selected. Therefore, they are not included in an ABC. The analyst should include a brief narrative account of significant sunk costs in the final report even though the costs do not affect the ABC.

Non-recurring costs are one-time expenses incurred under any alternative, such as site/facility construction, system design and programming, system testing, equipment or software purchase, and system documentation.

Recurring costs, on the other hand, are incurred on a regular basis throughout the investment/project or system lifecycle. Recurring costs are similar to the annual operating expenses of a business. Recurring costs include system operations and maintenance, telecommunications, supplies, equipment lease and maintenance, and salaries for personnel involved in system activities.

Exhibit 4-1 presents a representative listing of costs typically associated with IRM initiatives.

4.1 COST ACCOUNTING PROBLEMS

There are two main problems in cost accounting when computing system lifecycle costs—cost omissions and hidden costs.

Omitting costs is most common when dealing with overhead costs. Examples of easily overlooked costs include charges for space, electricity and changeovers when upgrading equipment. Omitting these costs may seriously distort the analysis.

Hidden costs are usually indirect costs or support activities which are allocated to an investment/project. They exist elsewhere in the organization, typically in a staff or service unit. Frequently, these costs are charged at a standard rate by an internal billing system. However, these charges are not always directly charged to the initiative. For example, excluding the costs of analysts and programmers, which work on the investment/project but were hired by an in-house service

organization, makes salary costs for data processing appear lower than they really are. Any support activity should be identified and its cost appropriately allocated to the initiative.

4.2 ESTIMATING COSTS

4.2.1 The Work Breakdown (Bottom-up) Approach

The traditional method of developing cost estimates is to add detailed work level data. This process, known as the bottom-up approach, separates the total product into discrete components. The analyst then establishes costs for each component.

An analyst charts the logical steps required by an alternative using a work breakdown structure or process flowchart. For example, the logical steps of a claims process might include initial processing, case determination, coding and review, and filing. Each step contains sub-actions which require time and equipment. The "bottom-up" approach costs the entire process by adding the costs of each sub-action. The result is a consolidation of individual work action estimates into a total end product or total investment/project cost.

This "bottom-up" approach requires considerable time and effort because it is so detailed. However, this approach yields the most accurate results. It is also easy to modify with new information or a revision to the alternative.

4.2.2 The Parametric Costing (Top-down) Approach

The "top-down" approach does not require the detail of the "bottom-up" approach. The analyst can reach an estimate of total costs with little or no difficulty. Using this approach, the analyst relates activities conducted in the alternative to similar activities with known costs. The same proportion of costs are assigned to activities in the system under analysis. The data developed is empirical and relies upon historical costs. However, this approach relies heavily upon the analyst to identify a cost relationship between the proposed alternative and an existing system. The prime advantage of this approach is that it does not rely on complete detailing of the work actions.

The "top-down" approach is also useful in obtaining the cost of the present system if one exists. Normally, managers know the total cost of an operation or activity. The analyst may then apportion the costs of the major functions.

4.3 COST ELEMENTS

4.3.1 Personnel Costs

Personnel resources are a principal and costly ingredient of many IRM initiatives. As such, the analyst must measure them as s/he would any other resource. (See Section 3.2.2 on measuring and quantifying personnel resources.)

4.3.2 Equipment Costs

Another important cost element of any system is equipment cost. This includes the initial acquisition cost, site preparation costs, installation, and operating costs during the alternative's lifecycle.

4.4 OTHER CONSIDERATIONS

Estimates of benefits and costs for each year of the analysis period should be expressed in current year dollars. Estimates should ***not***, include any factors to account for inflation.

Appendix A, pages A-8 through A-11 contain an example of the "Analysis of Costs."

EXHIBIT 4-1
TYPICAL COST CATEGORIES
FOR ALTERNATIVE IRM INVESTMENTS/PROJECTS

NON-RECURRING COSTS
(COSTS INCURRED ONLY ONCE)

EQUIPMENT PURCHASE (e.g., computing and/or telecommunications resources)

SOFTWARE PURCHASE

PERSONNEL (used only for personnel assigned to investment/project development)

Salaries

Overtime

Fringe Benefits

Training

Travel

SITE PREPARATION

CONVERSION/PARALLEL OPERATIONS

OTHER (identify)

RECURRING COSTS
(COSTS INCURRED THROUGHOUT THE INVESTMENT/PROJECT OR SYSTEM LIFE)

PERSONNEL

Salaries

Overtime

Fringe Benefits

Training

Travel

CONTRACTOR SERVICES

(e.g.; technical and consulting services, data entry support, operations support, timesharing services, facilities management, telecommunications network services)

EQUIPMENT

(e.g., computing and/or communications resources)

Acquisition (e.g., lease, lease-with-option-to-purchase, lease-to-ownership)

Maintenance

SPACE OCCUPANCY

Building Maintenance

Building Rental or Lease

Office Furniture

Utilities (heating, air-conditioning, power)

SOFTWARE

Acquisition (lease or rental)

Maintenance/Enhancement

OTHER OVERHEAD EXPENSES

OTHER (identify)

SUPPLIES

(e.g., office supplies, data processing materials, other miscellaneous expenses)

V. HOW TO COMPARE ALTERNATIVES—COMPUTATIONAL TECHNIQUES

During the initial steps of the ABC, the analyst identifies alternatives and estimates their benefits and costs. The later steps require the analyst to compare the benefits and costs of different alternatives. This chapter describes the techniques that permit comparison of alternatives.

5.1 PRESENT VALUE ANALYSIS

It is necessary to express the benefits and costs of different alternatives in terms of their present value. The benefits and costs of each alternative are likely to occur at different points in the analysis period. How does a decision-maker compare different benefits and costs when they occur at different intervals? Present value analysis allows an analyst to convert benefits and costs occurring at different times to their current value (i.e., present value). Present Value Analysis is based on two principles:

- Benefits accruing in the future are worth less than the same level of benefits that accrue now.
- Costs that occur in the future are less burdensome than costs that occur now.

Present value analysis assumes that a dollar received today is worth more than a dollar received tomorrow. A dollar invested today begins to earn interest immediately. A dollar received in the future cannot earn interest until it is invested. The difference in present value is the amount of interest earned by the dollar invested today before the future dollar can be invested.

The current year (year 0) establishes the time reference point for present value calculations. This is known as the baseline year. The present value analysis allows the value of future years' benefits and costs to be calculated as if they all occurred in this year.

Calculating the present value of benefits and costs is called discounting. This calculation multiplies the benefits and costs by a factor referred to as the discount rate, or opportunity cost of capital. A discount factor is a predetermined factor based on the established discount rate and time period. Discount factors used by the Department of Energy incorporate the discount rate specified by the Office of Management and Budget (OMB) in their Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, and published yearly in an OMB Memorandum, *YYYY Discount Rates for OMB Circular No. A-94*. Exhibit 5-1 shows the discount factors based on a 10 percent discount rate. Column 2 shows the "end-of-year" factors. These factors are used when benefits and costs are incurred toward the end of each year.

It is common for benefits and costs to occur more evenly throughout the year. A good example is monthly timesharing charges. It is also common for major cost elements to occur at the beginning or middle of the year. Thus, a more realistic discount factor would be an average factor for the year. Column 3 of Exhibit 5-1 shows average discount factors.

Choosing which factors to use depends on the investment/project being analyzed. Use the average factor if benefits or costs occur evenly throughout a year. Use the end-of-year factor if the timing of benefits and costs cannot be specified or if they occur in the latter part of a year.

The illustration shown in Exhibit 5-2 is a sample report which shows how to present a present value analysis. The one-time costs plus the recurring costs equal the total costs for the proposed alternative. In this illustration, costs and benefits occurred in the latter part of each year. Thus, the analyst used the end-of-year discount factors. Discounted costs were entered into the "Discounted Costs" column. The "Expected Yearly Benefit" column represents the discounted benefits associated with the proposed system.

5.2 NET PRESENT VALUE

Reducing all quantifiable benefits and costs to present value allows a comparison of the various alternatives. The most straightforward comparison is net present value (NPV).

NPV is the difference between the present value of the benefits and the present value of the costs, or: $NPV = PV(\text{benefits}) - PV(\text{costs})$. In the illustration in Exhibit 5-2, the present value of benefits is \$1,646,719, and the present value of cost is \$1,519,682. The NPV is \$127,037 ($\$1,646,719 - \$1,519,682$).

In other words, the quantifiable benefits for this alternative exceed costs (i.e., it makes a net contribution to value). Using NPV assists in selecting the most economical alternative (i.e., the alternative with the highest NPV). However, non-quantifiable benefits may show that an alternative with a lower NPV may be more desirable (i.e., quantifiable benefits may not be the sole criterion for choosing the best alternative). Mitigating factors such as different non-quantifiable benefits among the alternatives, large initial cash outlays, budgetary constraints, manpower restrictions, etc., may require selection of an alternative that does not have the highest NPV.

5.3 GRAPHIC PRESENTATION OF NET PRESENT VALUE

NPV provides decision-makers with a single measure of the alternative's value over the comparison period. Decision-makers may also find it useful to see the relationship of alternative cost patterns over the life of the investment/project. This helps them evaluate the impact of large initial cash outlays or budget constraints. Since most IRM investments/projects require substantial initial costs, the NPV in the early years will most likely be negative. In some cases, it may be important to recover the initial costs as quickly as possible.

Graphic representations can show the break-even points and payback periods for each alternative. Break-even points occur when the benefits and costs are equal (cumulative NPV equals 0). A payback period is the length of time required to reach the break-even point. Graphic representations of the NPV analysis should plot cumulative NPV for each alternative at the end of each year (i.e., the difference between the present value of benefits and the present value of costs from investment/project initiation through the end of the year). Either a line chart or bar chart is useful for depicting these comparisons.

Showing several alternatives on the same graph allows the decision-maker to compare the time required for each alternative to "break-even." It also shows the alternative whose NPV is largest at the end of the comparison. In addition, both graphs allow decision-makers to visually compare alternatives at any point in the lifecycle.

5.4 BENEFIT-COST RATIO

A variation of the net present value approach is the benefit-cost ratio or benefit-cost index. The benefit-cost ratio (BCR) is the present value of benefits divided by the present value of the cost or: $BCR = PV(\text{Benefits})/PV(\text{Costs})$. From our example, $BCR = 1,646,719/1,519,682$ or $BCR = 1.08$.

The benefit-cost ratio is a relative measure of an alternative's value. The BCR provides a measure of the benefits obtained per dollar spent. In the above example, for each dollar spent, about \$1.08 of estimated benefits are projected. The higher the BCR, the larger the return. NPV on the other hand is an absolute measure. In situations where funds are limited, the BCR provides decision-makers with an additional piece of information. In selecting among alternatives for a particular investment/project, the BCR shows which alternative provides the largest return relative to costs.

Appendix A, pages A-12 through A-13 contain an example of the comparison of alternatives.

EXHIBIT 5-1 DISCOUNT FACTORS BASED ON A 10 PERCENT DISCOUNT RATE

Investment/ Project Year	End of Year Discount Factor	Average Discount Factor
0	1.000	1.000
1	.909	.954
2	.826	.867
3	.751	.788
4	.683	.717
5	.621	.652
6	.564	.592
7	.513	.538
8	.467	.490
9	.424	.445
10	.386	.405

A discussion of the formulas for calculating the discount factor can be found in many texts on managerial economics. These books usually contain tables with the discount factors for a range of discount rates.

EXHIBIT 5-2
PRESENT VALUE ANALYSIS
ALTERNATIVE X
SUMMARY OF ALTERNATIVE BENEFITS AND COSTS

Organization =

Date =

Investment/Project Title =

Year Since Initiation	Expected Yearly Cost of Proposed System			Expected Yearly Benefit (Total of Current System)	Discount Factor (10%)	Present Value Costs (Discounted Costs) ^a	Present Value Benefits (Discounted Savings) ^b
	One-Time Costs +	Recurring Costs =	Total Costs				
0	100,000	0	100,000	0	1.000	100,000	0
1	173,150	235,300	408,450	306,730	.909	371,281	278,818
2	9,000	235,300	244,300	309,200	.826	201,792	255,399
3	0	235,300	235,300	309,200	.751	176,710	232,209
4	0	235,300	235,300	309,200	.683	160,710	211,184
5	0	235,300	235,300	309,200	.621	146,121	192,013
6	0	235,300	235,300	309,200	.564	132,709	174,389
7	0	235,300	235,300	309,200	.513	120,709	158,620
8	0	235,300	235,300	309,200	.467	109,650	144,087
Total						1,519,682	1,646,719
NPV = \$1,646,719 - \$1,519,682 = \$ 127,037							

^a The result of multiplying the Total Costs times the Discount Factor for each year.

^b The result of multiplying the Expected Yearly Benefit times the Discount Factor for each year.

NOTE: A summary sheet should be prepared for each alternative.

VI. HOW TO REFINE THE ANALYSIS

Even after measuring all benefits and costs and establishing a ranking of the alternatives, the ABC is not complete. Due to the uncertainties in the analysis (assumptions, estimates, etc.), the decision-maker(s) will want to know more than the results using one set of conditions. Specifically, they will want to know if a recommendation would change if one or more of the inputs to the ABC varied. Sensitivity analysis is a way of analyzing the effects of changes in input on the outcome (NPV BCR) of the alternative.

Sensitivity analysis is a what-if technique that tests whether a change in one or more inputs will affect the NPV ranking of alternatives. In a sensitivity analysis, input is varied to test the impact on the alternatives.

The analyst must first determine whether or not a sensitivity analysis is really necessary. If there is a high degree of certainty about the input to the ABC and the ranking of alternatives establishes one alternative as markedly superior to the rest, the analyst should not be overly concerned about testing for sensitivity. When there is uncertainty (i.e., where assumptions and key forecasts can be affected by external changes) and/or no alternative is clearly superior, the analyst should conduct a sensitivity analysis.

When conducting a sensitivity analysis, the analyst must select which input to test. The input selected will vary with the nature of the ABC. Each ABC is unique in that it has its own set of assumptions, forecasts, and estimates. As a rule sensitivity analysis should examine input which has a significant impact on NPV. The other factor to consider in selecting the input to examine is the confidence which is placed in the assumption or estimate. The input which should be considered is:

- **Cost Estimates**—Effects of increasing or decreasing major cost elements; i.e., those which have a significant impact on the present value cost.
- **Length of System Lifecycle**—Effects of a shorter or longer system lifecycle.
- **Volume, Mix, or Pattern of Workload**—Effects of variation in the forecast of volume, mix, or pattern of workload.
- **Requirements**—Effects of potential changes in requirements resulting from either legislative mandate or changes in functional or organizational structure.
- **Configuration of Equipment or Software**—Effects of changes in configuration of hardware, software, data communications, and other facilities.
- **Conversion Costs**—Effects of variation in costs of the program conversion efforts. The cost of the conversion process may vary depending on the adjustments necessary to use the current program with the new equipment.

One way to conduct a sensitivity analysis is to use probability matrices. The probability matrix depicts the value of an input or a series of possible forecasts. The analyst would construct a similar matrix for all input being tested. The analyst can then determine the effect of the changes in any input on the NPV of the alternatives. However, because input does not usually change one at a time, the analyst can combine the matrices into several scenarios. The NPV of the alternatives under different scenarios can then be compared to the original ranking. Appendix A, pages A-14 and A-15 contain an example of the "Sensitivity Analysis" matrix for benefit estimates.

APPENDIX A

EXAMPLE – SYSTEM “X” ABC

EXAMPLE -- SYSTEM "X" ABC

I. DEFINING THE INITIATIVE

I.1. INTRODUCTION

In 1980, the agency developed System X to process payroll, time and attendance, and related personnel information. System X runs on minicomputers at 15 sites around the country. The current system requires modification to comply with requirements changed by the Office of Management and Budget (OMB) and the Office of Personnel Management (OPM). In addition, the agency has several planned system modifications designed to increase efficiency and timeliness. Not all sites are capable of supporting the new requirements because of an inadequate central processing unit (CPU), memory capacity, and input/output connections.

I.2. OBJECTIVES

The System X reference manual identifies the following objectives:

- Maintain a single human resource database that includes all necessary employee data.
- Provide access to individual and summary data for authorized managers.
- Process all personnel and time reporting transactions efficiently.
- Provide statistical reports for submission to Congress, OMB, and OPM.
- The system redesign team developed specific objectives for the proposed system modifications.
- Enhance system edits, validity checks, and processes to improve the accuracy of system information.
- Conform to new and revised regulations, legislation, and external requirements.
- Eliminate manual preparation of reports and updates.

This ABC focused on selecting a configuration that would be capable of implementing all requirements. The objective of this ABC is to examine the benefits and costs of alternative equipment configurations capable of satisfying these objectives.

I.3. ASSUMPTIONS

The following assumptions were made in conducting the analysis. These assumptions formed the basis for analysis, extrapolations and projections.

EXAMPLE -- SYSTEM "X" ABC

- The lifecycle of each alternative is seven (7) years. At that point, additional computer resources will be required.
- The comparison period is the same as the assumed lifecycle (7 years) beginning in FY 20XX (year 0).
- Current computer equipment can be exchanged for a credit during upgrade of the existing vendor's equipment.
- All minicomputer upgrades will remain in the existing vendor's line of equipment.
- All new equipment will be delivered in September 20XX.
- Existing workload and operating costs will remain constant during the comparison period.
- Incremental benefits will be analyzed for items where alternative(s) improve upon the current system.

I.4. ALTERNATIVES

Four alternatives were considered during the analysis. A fifth alternative, to redesign System X, was originally considered. However, since a redesign could not be completed in time to meet new OPM requirements, it was excluded from further analysis. The following alternatives are capable of meeting all requirements.

- **Baseline (Status Quo).** System X will continue to operate as it does today. System modifications will be made to maintain performance at current levels. New requirements will be met by increasing manual processing of system information. No planned enhancements will be implemented.
- **Shared Upgrade.** The existing computer equipment will be replaced by eight new minicomputers. Each new computer will support the operations of two locations. (Headquarters will not share with any other location.) Half of the locations would be linked to a computer at another location via telecommunications. All planned enhancements and additional requirements will be phased in over the lifecycle of the equipment.
- **Total Upgrade.** The existing computer equipment will be replaced by 15 new minicomputers. Each location will receive a new computer. All planned enhancements and additional requirements will be phased in over the lifecycle of the equipment.
- **Conversion to Centralized Hardware.** System X will be replaced with a mainframe system. Each location will be linked to the host computer via leased lines. Current software will be

EXAMPLE – SYSTEM “X” ABC (continued)

converted to run on the mainframe. Current operations, planned enhancements, and new equipments will be implemented by Year 4 of the comparison period.

II. ANALYSIS OF BENEFITS

The benefits that should result from a redesign of System X can be organized into two categories: quantifiable and non-quantifiable. Quantifiable benefits represent clear monetary savings through cost-reduction and cost-avoidance. Non-quantifiable benefits result from greater efficiency of operations and include areas such as improved employee morale and increased management efficiency.

II.1. QUANTIFIABLE BENEFITS

Quantifiable benefits were established in four categories:

- Cost-avoidance—personnel
- Cost-reduction—equipment maintenance
- Cost-reduction—forms printing and storage
- Non-recurring benefit—trade-in value of equipment.

Benefits were measured individually for each location and then summarized for the entire system. (Detailed estimates by location are not included in this example.)

II.1.A. Cost-avoidance—Personnel

Revisions to System X are needed to meet new requirements. Site visits were made to five locations to investigate how these changes could be implemented. Workflows and processing times were developed by the analyst in conjunction with supervisors and managers. Estimates of the number of transactions and reports were developed by the System X manager. This provided an estimate of the number of full-time employees (FTEs) required to accomplish the changes. Phone interviews were conducted with managers at the remaining locations to assure that estimates were reasonable. This process resulted in an estimate of the number of FTEs required to implement changes at each site. These estimates represent personnel who will not be required if one of the alternatives to the status quo is selected.

For the shared and total upgrade alternative, these benefits were phased in over a 5-year period beginning in Year 1. This accounts for the time required to develop, test, and implement the changes. For the conversion alternative, full enhancement is expected at implementation of the new system in Year 4.

FTEs were converted to dollars using an average cost of \$45,000 per FTE. This represents the average cost of current System X staff including fringe benefits and identifiable overhead.

EXAMPLE – SYSTEM “X” ABC (continued)

II.1.B. Cost-reduction—Equipment Maintenance

The agency currently pays \$120,000 for a 1-year, 4-hour response maintenance agreement on 15 computers. The cost for a similar agreement for the proposed replacement minicomputers is \$106,500 for the share upgrade alternative and \$115,000 for the total upgrade alternative. The savings were based on price quotes from the current maintenance contractor. The cost for maintenance on the mainframe would be shared with other resident systems. The estimated allocation of costs to System X was \$125,000. This estimate was provided by the manager of administrative computing based on recent allocations to similar systems. Therefore, no benefit was added for the conversion alternative.

II.1.C. Cost-reduction— Form Printing and Storage

The agency currently pays \$10,000 per year to print forms required for system input and reporting. In addition, the system is assessed \$90,000 per year by warehouse operations for storage and distribution of forms to 15 sites. Proposed system enhancements will eliminate the need for two different forms. These forms represent about 5 percent of all forms used by the system (based on a 1-month sample at 5 locations). This reduction results in a \$5,000 savings to the agency for all alternatives. Since these are listed as the top priority for system enhancement by both managers and systems operations, they will be implemented first. Benefits are anticipated to begin in Year 1 for the total and shared upgrade alternatives and in Year 4 for the Conversion Alternative.

II.1.D. Non-Recurring Benefit—Trade-in Value of Equipment

For the shared and total upgrade alternatives, a proposed equipment configuration was developed for each site. Where possible, existing equipment (disk packs, terminals, etc.) was used in these configurations. The analysts then developed a list of surplus equipment. Since the current equipment manufacturer provides a credit to customers who upgrade within the same product line, they were asked for a quote on the list of displaced equipment. These figures were included as a non-recurring benefit in Year 0 for the shared and total upgrade alternatives.

No trade-in credit would be available under the conversion alternative. Excess equipment is assumed to be used by the agency for other applications.

II.1.E. Summary

The analysts completed a benefit analysis worksheet for each alternative. The benefit worksheet provided the total benefits for the alternative in each year of the comparison period. Exhibit E-1 shows the benefit analysis worksheet for the shared upgrade alternative. Exhibit E-2 summarizes the total benefits for each alternative and provides the net present value for the benefits. As shown by the net present value figures, the benefits for the shared and total upgrade are very

EXAMPLE – SYSTEM “X” ABC (continued)

close (less than 1 percent difference). The benefits for the conversion and baseline alternative are substantially less (more than 20 percent) than the other two alternatives.

II.2. NON-QUANTIFIABLE BENEFITS

In addition to the benefits described above, significant non-quantifiable benefits were identified for the alternatives. The non-quantifiable benefits include:

- **Increased Workload Capacity**—the ability of the system to handle unanticipated workload increases and requirements without significant time delays.
- **Increased Technological Capacity**—the ability of the system to utilize future hardware and software enhancements without significant additional monetary outlay.
- **Employee Morale**—user perceptions that they are using the latest technology, which provides improvements over older equipment and increases interest and curiosity in the system. For some alternatives, morale may be reduced by the removal of local computers.
- **Management Efficiency**—as a result of faster data processing, reports and other relevant information can be made available more quickly, resulting in a more timely decision-making process.
- **Access to Data**—along with the new system there will be enhancements which will allow supervisors to access information directly, rather than requesting it from a personnel office.

A committee of agency personnel was formed to evaluate non-quantifiable benefits. The personnel represented a sample of agency managers, supervisors, and System X operating staff. Both Headquarters regional offices were represented. Exhibit E-3 shows the results of this process for Alternative B.

The committee members were first asked to rank each of the five benefits in order of importance. The individual rankings were combined to produce the ranking in column 1 of Exhibit E-3. The benefits were assigned weights representing the consensus of the committee on the relative importance of each benefit (column 3).

The analyst then made a presentation describing each of the possible alternatives. Following the presentation, the committee members were asked to score the benefits for each alternative. A scale of 0 (no benefit) to 10 (maximum benefit) was used to score the benefits. The analyst calculated the average score for each benefit on all alternatives. These scores were multiplied by the benefit weight to provide a weighted score. The sum of the weighted scores provides the final score for each alternative.

EXAMPLE – SYSTEM “X” ABC (continued)

As shown in the following table, the total upgrade received the highest score from the evaluation. The total upgrade score (230) is approximately 10 percent higher than the shared upgrade alternative (206).

ALTERNATIVE	FINAL SCORE
Total Upgrade	230
Shared Upgrade	206
Conversion	142
Baseline	100

EXHIBIT E-1

**U.S. DEPARTMENT OF ENERGY
INFORMATION RESOURCES MANAGEMENT - ABC
BENEFIT ANALYSIS**

ALTERNATIVE: B—SHARED (000's omitted)

Benefit Category	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Non-recurring Benefits								
Upgrade Credit	618							618
Subtotal	618							618
Recurring Benefits								
Cost Avoidance Personnel		113.0	495.0	878.0	1,215.0	1,620.0	1,935.0	6,256.0
Cost Reduction Maintenance		13.5	13.5	13.5	13.5	13.5	13.5	81.0
Forms		5.0	5.0	5.0	5.0	5.0	5.0	30.0
Subtotal		131.5	513.5	896.5	1,233.5	1,638.5	1,953.5	6,367.0
TOTAL BENEFITS	618	131.5	513.5	896.5	1,233.5	1,638.5	1,953.5	6,985.0

EXAMPLE – SYSTEM “X” ABC (continued)

EXHIBIT E-2

**U.S. DEPARTMENT OF ENERGY
INFORMATION RESOURCES MANAGEMENT - ABC
BENEFIT SUMMARY**

SYSTEM X UPGRADE (000's omitted)

ALTERNATIVE	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total	PRESENT VALUE BENEFITS
Current	1,000	750	500	250	0	0	0	2,500	2,283
Shared	618	131	513	897	1,233	1,639	1,954	6,985	5,004
Total	646	134	516	900	1,236	1,642	1,956	7,030	5,045
Conversion	0	0	0	0	1,940	1,940	1,940	5,820	3,804

EXHIBIT E-3

**NON-QUANTIFIABLE BENEFITS
WEIGHTED RANKING CHART**

ALTERNATIVE B—SHARED UPGRADE

RANK	BENEFIT	WEIGHT	ALTERNATIVE SCORE	WEIGHTED SCORE
1	Management Efficiency	10	7	70
2	Increased Workload Capacity	8	10	80
3	Access to Data	6	6	36
4	Increased Technological Capacity	4	5	20
5	Employee Morale	2	0	0
	Total Alternative Score			206

EXAMPLE - SYSTEM “X” ABC (continued)

III. ANALYSIS OF COSTS

The results of the cost analysis of four alternatives to meet System X requirements are discussed below. Costs have been divided into three major categories:

- Sunk costs
- Non-recurring costs
- Recurring costs

III.1. SUNK COSTS

Sunk costs are expenditures resulting from past decisions. Sunk costs are not included in the comparison of alternatives since they would be the same for all alternatives. Prior to initiation of the ABC, the agency contracted with a consultant to produce a long-range plan for System X. The cost of this study and associated agency costs was \$14,485. In addition, the current support contractor was tasked to produce system requirements for planned enhancements and new requirements. This task cost \$24,900. The total sunk costs for this upgrade are \$39,385.

III.2. NON-RECURRING COSTS

Non-recurring costs are those expenses required for purchase of new equipment and modification of existing software. These expenses are incurred only once at the beginning of the comparison period. Three different non-recurring costs were identified for this analysis:

- Equipment purchase
- System migration
- Software modification

III.2.A. Equipment Purchase

All equipment prices are based on price quotes from the General Services Administration (GSA). For the conversion alternative, the estimated cost was based on an enhancement to the mainframe in the agency’s computer center.

The analysts developed a proposed equipment configuration for each alternative. For the total and shared upgrade alternatives, analysts developed a list of required equipment by location. These lists formed the basis for the GSA price quotes. For the conversion alternative, computer center staff developed an estimate of additional resources required to run System X. This estimate was the basis for the GSA price quote.

EXAMPLE - SYSTEM “X” ABC (continued)

III.2.B. System Migration

System migration costs are the expenses associated with physically replacing the existing computer equipment. In the past 2 years, the agency has replaced several minicomputers. While the same brand of equipment was not involved, the situations are similar enough to use those costs as a starting point. The average cost for the recent replacements was \$4,625. The analysts added an additional \$1,000 to the estimate to account for variations among locations and price increases. The price for each minicomputer replaced was estimated at \$5,625.

The costs for the conversion alternative were based on expanding the agency's computer center. Conversion of System X would require addition of both central processing unit core and additional disk packs. Since the computer center has no additional room, an addition would be required. The Facilities Design and Construction Division provided a preliminary layout and cost estimate to build this addition.

III.2.C. Software Modification

Software modification covers the cost to modify current software to operate in the new computing environment. The shared and total upgrade alternatives assumed the new equipment would be provided by the same manufacturer. The current support contractor was asked to estimate the cost of moving the software to the new equipment. The contractor estimated an effort of 1.5 person-years. Using the current average cost per person-year under the current support contract (\$50,000), an estimate of \$75,000 was used for software modification on these alternatives.

For the conversion alternative, an estimate of \$3,099,000 was developed. This estimate is based on an analysis using the Conversion Cost Model (version 2) of the Federal Conversion Support Center, Office of Software Development, General Services Administration. This model is considered to be a highly valid algorithm for generating conversion costs.

III.3. RECURRING COSTS

Recurring costs are the ongoing operating expenses of System X. These costs are incurred throughout the comparison period. Three different recurring costs were identified in the analysis:

- Training
- Telecommunications
- System support

EXAMPLE - SYSTEM “X” ABC (continued)

III.3A. Training

Since the shared and total upgrade alternatives assume the same operating environment (terminals, data entry screens, etc.), it was determined that there would be no system training cost. For the conversion alternative, it was determined that a two-day training session would be required to instruct users in the new operating environment. The Training Division provided an estimate of \$500/person for an in-house course. This estimate was based on a similar course currently provided to System Z users. Based on 250 active users, the cost of training is \$125,000. This cost is included in Year 3, under the assumption that training must be completed prior to implementation in Year 4.

III.3.B. Telecommunications

Telecommunication charges are anticipated in the shared upgrade and conversion alternatives. These alternatives require many locations to link to a remote computer. In the shared upgrade alternative, they link to a minicomputer at another location. In the conversion alternative, they link to the mainframe at the computer center. Costs were developed using data provided by the computer center. The current cost for a leased line is \$500 per month, or \$6,000 per year.

In the shared upgrade alternative, seven locations will require a leased line to process System X transactions. In addition, Headquarters will require a leased line to transmit System X updates to each installed minicomputer. The shared upgrade requires a total of eight leased lines at an annual cost of \$48,000. For the conversion alternative, all 15 sites will require a leased line at an annual cost of \$90,000.

III.3.C. System Support

System support costs are associated with the maintenance and operation of the System X software. Currently, the agency contracts for this support through the computer center. This support is adequate for shared and total upgrade alternatives since there will be no major changes to the system. Based on the computer center Director's experience with similar systems, an estimate of five additional contractor staff would be required to support mainframe operation of System X. This addition would include software support, computer operations, and telecommunications support. The total cost for this support was estimated at \$200,000 per year.

III.4. SUMMARY

The analysts completed cost analysis worksheets for each alternative. The cost worksheets were developed for all locations and summarized into a single worksheet for each alternative. The summary worksheet provides the total cost for the alternative in each year of the comparison period. Exhibit E-4 shows the cost analysis worksheet for the shared upgrade alternative. Exhibit E-5 summarizes the total costs for each alternative and provides the net present value of

EXAMPLE - SYSTEM “X” ABC (continued)

the costs. As shown in Exhibit E-5, the conversion alternative is 50 percent more expensive than the other alternatives. The costs for the remaining alternatives vary by less than 10 percent.

EXHIBIT E-4

**U.S. DEPARTMENT OF ENERGY
INFORMATION RESOURCES MANAGEMENT - ABC
COST ANALYSIS**

ALTERNATIVE: B—SHARED (000's omitted)

Cost Category	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Non-recurring Costs								
Equipment Purchase	3,667							3,667
System Migration	45							45
Software Modification	75							75
Subtotal	3,787							3,787
Recurring Costs								
Telecommunications	48	48	48	48	48	48	48	336
Subtotal	48	48	48	48	48	48	48	336
TOTAL COSTS	3,835	48	48	48	48	48	48	4,015

EXHIBIT E-5

**U.S. DEPARTMENT OF ENERGY
INFORMATION RESOURCES MANAGEMENT - ABC
COST SUMMARY**

SYSTEM X UPGRADE (000's omitted)

ALTERNATIVE	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total	PRESENT VALUE BENEFITS
Current	763	763	763	763	763	763	763	5,341	4,250
Shared	3,727	48	48	48	48	48	48	4,015	3,946
Total	4,272							4,272	4,272
Conversion	4,316	466	466	591	466	466	466	7,237	6,544

EXAMPLE - SYSTEM “X” ABC (continued)

IV. COMPARISON OF ALTERNATIVES

The four alternatives were compared using both net present value analysis (NPV) and benefit-cost ratio (BCR). In this study, both the NPV analysis and BCR rank the shared upgrade alternative as the best choice.

A summary sheet was prepared for each alternative showing the benefits and costs for each year in the comparison period. These were converted to present value using the average discount factor. Average discount factors were used because both costs and benefits are spread out over 12 months in each year. Exhibit E-6 shows an alternative summary sheet.

Exhibit E-7 shows the NPV and BCR for each alternative. As seen in Exhibit E-7, the conversion alternative and the present system (baseline) are not economically desirable. On the other hand, both the shared and total upgrade alternatives appear to be desirable. Both have positive NPVs and BCRs greater than one.

The NPV of the shared upgrade alternative is \$284,522, higher than the total upgrade alternative. This is a difference of approximately 37 percent. The BCR ratio of the shared upgrade alternative is also clearly superior to all other alternatives. The total upgrade alternative was evaluated as marginally better than the shared upgrade alternative on non-quantifiable benefits. This difference is clearly outweighed by the higher NPV of the shared upgrade. Therefore, based on the analysis of benefit and costs, the shared upgrade alternative is clearly the recommended alternative.

Exhibit E-8 illustrates the cumulative NPV of the alternatives throughout the comparison period. Both graphs show that the total and shared upgrade alternatives break even during Year 6. The cumulative benefits outweigh the cumulative costs at this point. The NPV of the conversion alternative is negative throughout the comparison period. This indicates that the benefits never equal the costs of this alternative. The graphs also show that the cumulative NPV of the current system is positive for the first several years of the period. This is due to the lack of equipment costs for this alternative. However, increasing maintenance costs and declining benefits cause the cumulative NPV to be negative by Year 3. For the remainder of the comparison, the NPV of this alternative continues to decline.

EXAMPLE - SYSTEM “X” ABC (continued)

EXHIBIT E-6

**U.S. DEPARTMENT OF ENERGY
INFORMATION RESOURCES MANAGEMENT - ABC
ALTERNATIVE SUMMARY**

INVESTMENT/PROJECT: SYSTEM X UPGRADE

ALTERNATIVE: B—SHARED (000's omitted)

Category	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Total Costs	3,727	48	48	48	48	48	48	4,015
Present Value Costs	3,727	46	42	38	34	31	28	3,946
Total Benefits	618	131	513	897	1,233	1,639	1,954	6,985
Present Value Benefits	618	125	445	707	884	1,068	1,157	5,004
Net Present Value	(3,109)	798	403	669	850	1,037	1,129	1,058

EXHIBIT E-7

**U.S. DEPARTMENT OF ENERGY
INFORMATION RESOURCES MANAGEMENT - ABC
COMPARISON OF ALTERNATIVES**

SYSTEM X UPGRADE (000's omitted)

ALTERNATIVE	PRESENT VALUE COSTS	PRESENT VALUE BENEFITS	BENEFIT/ COST RATIO	PRESENT VALUE BENEFITS
Current	4,249,910	2,283,000	(1,966,910)	.54
Shared	3,946,360	5,004,038	1,057,678	1.27
Total	4,272,000	5,045,156	773,156	1.18
Conversion	6,544,120	3,804,340	(2,739,780)	.56

EXAMPLE - SYSTEM "X" ABC (continued)

V. SENSITIVITY/RISK ANALYSIS

The data used to produce quantitative estimates of benefits and costs relied heavily on past experiences with similar systems. In addition, personnel cost-avoidance estimates relied on the judgment of experienced managers. The sensitivity/risk analysis discusses what the ABC results would be if more pessimistic estimates of benefits and costs were used.

The initial analysis indicated that the shared alternative is the most desirable of the alternatives. In order to test the sensitivity/risk of this analysis to changes in benefits and costs, three possible scenarios were developed and analyzed:

- Reducing benefit estimates by 10 percent
- Increasing cost estimates by 10 percent
- A "worst case" scenario where benefit estimates are reduced by 10 percent and cost estimates are increased by 10 percent.

Both benefit and cost estimates rely to some extent on the judgment and estimates of agency staff. Given this source, the ABC team decided that a 10 percent overstatement of benefits and understatement of costs was a realistic possibility. (In the ABC team's judgment, these estimates were 90 percent reliable). The NPV of each alternative was recalculated after reducing benefits and increasing costs. In addition, a "worst case" scenario was analyzed where benefits were decreased and costs increased.

Exhibit E-9 shows the results of the sensitivity/risk analysis. The exhibit reflects the changes in the NPV of each alternative under the three sensitivity/risk scenarios. As expected, the reduction in benefits and increase in costs led to decrease in the NPV of all alternatives. In both cases, the shared and total upgrade alternatives remained economical. Neither scenario changed the ranking of the alternatives, with the shared upgrade alternative clearly superior.

Under the "Worst Case" scenario, the NPV of the total upgrade alternative becomes negative. Even under this scenario, the shared upgrade alternative's NPV was still a positive \$224,000.

The results of the sensitivity/risk analysis show that a reduction in benefits or an increase in costs result in corresponding reductions in the NPV of all alternatives. Further, under all scenarios, the shared upgrade alternative is clearly superior. This reinforces the results of the original ABC analysis.

EXAMPLE - SYSTEM “X” ABC (continued)

EXHIBIT E-9

**SENSITIVITY ANALYSIS
NPV OF ALTERNATIVES UNDER
VARYING ASSUMPTIONS**

ALTERNATIVE	ORIGINAL ABC	10% BENEFIT REDUCTION	10% COST INCREASE	WORST CASE SCENARIO
SHARED	\$1,058	\$621	\$661	\$224
TOTAL	\$ 773	\$338	\$346	(\$89)
CONVERSION	(\$2,740)	(\$3,120)	(\$3,399)	(\$3,779)

APPENDIX B

SAMPLE FORMS

INSTRUCTIONS FOR COMPLETING INFORMATION RESOURCES MANAGEMENT ABC SUMMARY EXHIBITS

The forms presented in this appendix provide suggested formats for presenting the results of an ABC. It is not required that these exact forms be used for every ABC. However, it is essential that the information contained in these exhibits be displayed for decision-makers. Most analysts will find that a spreadsheet can perform the necessary calculations and print the summary forms.

There are six different forms suggested in this appendix. Each form portrays different aspects of the ABC.

COST ANALYSIS—This form displays the cost estimates for a single alternative. It summarizes both recurring and non-recurring costs over the life of the investment/project. A copy of this form should be included in the cost chapter of the ABC report for every alternative considered.

BENEFIT ANALYSIS—This form displays the benefit estimates for a single alternative. It summarizes both recurring and nonrecurring benefits over the life of the investment/project. A copy of this form should be included in the benefit chapter of the ABC report for every alternative considered.

ALTERNATIVE SUMMARY—This form displays the actual and present value costs and benefits for a single alternative. This form can be included in the chapter of the ABC that compares the alternatives

COST SUMMARY—This form displays the costs for all the alternatives in the analysis. It also displays the total present value costs for each alternative. This form serves as a summary of the cost chapter of the ABC report.

BENEFIT SUMMARY—This form displays the benefits for all the alternatives in the analysis. It also displays the total present value benefits for each alternative. This form serves as a summary of the benefit chapter of the ABC report.

COMPARISON OF ALTERNATIVES—This form displays the net present value and benefit-cost ratio for all alternatives. This form provides a decision-maker with the critical information from the ABC. This form summarizes the entire ABC and should be included in the chapter of the report that compares alternatives.

A.1 FORM 1 — COST ANALYSIS

A separate cost analysis form should be completed for every alternative. The alternative should be identified at the top of the form. Exhibit 4-1 shows typical costs for an IRM investment/project.

(1) NON-RECURRING COSTS

The non-recurring cost items for the alternative should be listed in the appropriate block of column 1. The cost estimate for each line item should be inserted into the column for the year in which the cost will occur. Year 0 is the current fiscal year. Each non-recurring cost should appear in only one year. The one exception to this rule is where development costs are incurred for more than one year.

(2) SUBTOTAL

Enter the sum of the non-recurring costs for each year in the investment/project life.

(3) RECURRING COSTS

The recurring cost items for the alternative should be listed in the appropriate block of column 1. The estimate for each year where cost will be incurred for a particular line item should be inserted in the column for that year.

(4) SUBTOTALS

Enter the sum of the recurring costs for each year in the investment/project life.

(5) TOTAL COSTS

Enter the sum of the non-recurring cost subtotal and the recurring cost subtotal for each year of the investment/project life.

(6) TOTAL

Enter the sum of entries in all years for each line item.

U.S. DEPARTMENT OF ENERGY
 INFORMATION RESOURCES MANAGEMENT - ABC
 COST ANALYSIS

ALTERNATIVE:

COST CATEGORY	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	TOTAL
Non-recurring Costs								
Subtotal								
Recurring Costs								
Subtotal								
TOTAL COSTS								

A.2 FORM 2 — BENEFIT ANALYSIS

A separate benefit analysis form should be completed for every alternative. The alternative should be identified at the top of the form, Exhibits 3-1 and 3-2 show typical benefits for an IRM investment/project.

(1) NON-RECURRING BENEFITS

The non-recurring benefits for the alternative should be listed in the appropriate block of column 1. Non-recurring benefits are those benefits that occur at one specific point in the investment/project life. An example of a non-recurring benefit is the trade-in credit for old equipment. The dollar estimate for each non-recurring benefit should be inserted in the column for the year in which the benefit will be realized.

(2) SUBTOTAL

Enter the sum of the non-recurring benefits for each year in the investment/project life.

(3) RECURRING BENEFITS

The recurring benefits for the alternative should be listed in the appropriate block of column 1. Recurring benefits are those that occur in more than one year during the investment/project life. Productivity savings are a frequent recurring benefit in IRM investments/projects. The dollar estimate for each year where a benefit will be realized for a particular line item should be inserted in the column for that year.

(4) SUBTOTAL

Enter the sum of the recurring benefits for each year in the investment/project life.

(5) TOTAL BENEFITS

Enter the sum of the non-recurring benefit subtotal and the recurring benefit subtotal for each year of the investment/project life.

(6) TOTAL

Enter the sum of entries in all years for each line item.

U.S. DEPARTMENT OF ENERGY
 INFORMATION RESOURCES MANAGEMENT - ABC
 BENEFIT ANALYSIS

ALTERNATIVE:

BENEFIT CATEGORY	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	TOTAL
Non-recurring Benefits								
Subtotal								
Recurring Benefits								
Subtotal								
TOTAL BENEFITS								

A.3 FORM 3 — ALTERNATIVE SUMMARY

A summary should be completed for every alternative. The alternative summary includes the calculation of the net present value.

(1) TOTAL COSTS

The total cost for each year of the investment/project life should be inserted in the appropriate column. These numbers can be found at the bottom of each column of the cost analysis.

(2) PRESENT VALUE COSTS

The present value cost for each year should be calculated by multiplying the total cost by the appropriate discount factor. A discussion of how to select the appropriate discount factor can be found in Section 5.1. The results of the calculation should be entered in the appropriate column and summed in the last column.

(3) TOTAL BENEFITS

The total benefits for each year of the investment/project life should be inserted in the appropriate column. These numbers can be found at the bottom of each column of the benefit analysis.

(4) PRESENT VALUE BENEFITS

The present value cost for each year is calculated by multiplying the total benefit for each year by the appropriate discount factor. A discussion of how to select the appropriate discount factor can be found in Section 5.1. The results of the calculation should be entered in the appropriate column and summed in the last column.

(5) NET PRESENT VALUE

Determine the net present value for each year by subtracting the present value costs from the present value benefits.

U.S. DEPARTMENT OF ENERGY
 INFORMATION RESOURCES MANAGEMENT - ABC
 ALTERNATIVE ANALYSIS

INVESTMENT/PROJECT:
 ALTERNATIVE:

CATEGORY	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	TOTAL
Total Costs								
Present Value Costs								
Total Benefits								
Present Value Benefits								
NET PRESENT VALUE								

A.4 FORM 4 — COST SUMMARY

The cost summary is a comparison of the costs for all alternatives. This form is usually provided as part of the comparison of alternatives. It is simply a summary of the various cost analysis forms.

(1) **ALTERNATIVE (column 1)**

List the short title of each alternative in this column.

(2) **YEAR 0 THROUGH TOTAL (columns 2 through 9)**

Insert the total costs from the bottom of the cost analysis forms.

(3) **PRESENT VALUE COSTS**

Insert the present value cost for the alternative from row 2, column 9 of the alternative summary forms.

U.S. DEPARTMENT OF ENERGY
 INFORMATION RESOURCES MANAGEMENT - ABC
 COST SUMMARY

ALTERNATIVE	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	TOTAL	PRESENT VALUE COSTS

A.5 FORM 5 — BENEFIT SUMMARY

The benefit summary is a comparison of the benefits associated with all alternatives. This form is usually provided as part of the comparison of alternatives. It is simply a summary of the various benefit analysis forms.

(1) **ALTERNATIVE (column 1)**

List the short title of each alternative in this column.

(2) **YEAR 0 THROUGH TOTAL (column 2 through 9)**

Insert the total benefits from the bottom of the benefit analysis forms.

(3) **PRESENT VALUE BENEFITS**

Insert the present value benefit for the alternative from row 4, column 9 of the alternative summary forms.

U.S. DEPARTMENT OF ENERGY
 INFORMATION RESOURCES MANAGEMENT - ABC
 BENEFIT SUMMARY

ALTERNATIVE	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	TOTAL	PRESENT VALUE BENEFITS

A.6 FORM 6 — COMPARISON OF ALTERNATIVES

This form summarizes the key elements of the ABC. It should be included in the chapter of the ABC report dealing with the comparison of alternatives.

(1) **ALTERNATIVE (column 1)**

List the short title of every alternative in this column.

(2) **PRESENT VALUE COSTS (column 2)**

Enter the present value cost for each alternative from row 2 column 9 of the alternative summary form.

(3) **PRESENT VALUE BENEFITS (column 3)**

Enter the present value benefit for each alternative from row 4, column 9 of the alternative summary form.

(4) **NET PRESENT VALUE (column 4)**

Enter the net present value for each alternative from row 5, column 9 of the alternative summary form.

(5) **BENEFIT-COST RATIO (column 5)**

Calculate the benefit-cost ratio for each alternative by dividing the present value benefits by the present value costs (column 3 / column 2). See Section 5.3 for a discussion of the benefit-cost ratio.

U.S. DEPARTMENT OF ENERGY
 INFORMATION RESOURCES MANAGEMENT — ABC
 COMPARISON OF ALTERNATIVES

ALTERNATIVE	PRESENT VALUE COSTS	PRESENT VALUE BENEFITS	NET PRESENT VALUE	BENEFIT/COST RATIO